UMHS Program and Operations Analysis Department

Orders Management Medication Project (OMP)

Final Report

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Shortage of Tubes in the Pharmacy……………………………………………………………21
UMCL Downtime between 6-7 pm……………………………………………………………21
Communication Issues between Pharmacists and Pharmacy Technicians………………21
Medications that are not found in UMCL System…………………………………………22
Physicians Order STAT when it is not Needed……………………………………………22
Pharmacists Pulled Away from Verifying Orders…………………………………………22
Conclusions and Recommendations…………………………………………………………22
Appendix A: Literature Search…………………………………………………………………24
Appendix B: Process Flow Chart Comparison………………………………………………25
Appendix C: Average Walk Times………………………………………………………………26
Appendix D: Physician Survey…………………………………………………………………27
Appendix E: Survey Results……………………………………………………………………28
Figures and Tables

Figure 1: Flowchart of TAT .............................................................10
Figure 2: Box Plots of TAT Intervals .............................................10
Figure 3: Comparison of non-Omnicell orders Pre and Post UMCL Implementation .............11
Figure 4: TAT Frequency .............................................................13
Figure 5: Comparison of Omnicell orders Pre and Post UMCL Implementation .................14
Figure 6: Comparison of TAT between Units within Mott .............................................16
Figure 7: Perceptions on TAT Post UMCL Implementation .........................................17
Figure 8: Perceptions of Employees by Years Worked at UMHS ....................................18
Figure 9: Perceptions of Employees by Age Groups ....................................................19
Figure 10: Perceived TAT of Employees by Unit .........................................................20
Figure E-1: Response to Statement – Patients Receive their Medications quicker since we Implemented UMCL .................................................................28
Figure E-2: Response to Statement - Medications that come from the pharmacy are available to the nurse when she needs them (i.e. the first time she looks for them) ..................28
Figure E-3: Perceived TAT .................................................................................29

Table 1: Descriptive Statistics of TAT Data Post-UMCL .............................................12
Table 2: UMCL Medication Entries ........................................................................15
Table 3: Mar Form Data .........................................................................................15
Table 4: Perceived TAT Pre and Post UMCL Implementation ..................................18
Table C-1: Average Walk Times ...........................................................................26
Table E-1: Descriptive Statistics – Perceived STAT TAT By Staff position (minutes) ............29
Table E-2: Descriptive Statistics – Perceived STAT TAT By Unit (minutes) ...................30
Executive Summary

The University of Michigan Health System has implemented a new prescription order entry system called UM-CareLink (UMCL). UMCL is expected to improve the turnaround time (TAT) on prescriptions from order writing to administration in comparison to the previous paper ordering system. The project team’s task was to determine if UMCL improved TAT, specifically analyzing STAT orders, and to quantify the results with data.

Prior to UMCL, physicians wrote prescriptions on paper. This process presented many problems. The paper system did not have a reliable date/time stamp nor did it contain easily accessible records on patient’s medical history. Also, there were considerably large wait times between the time the physician wrote the order and the time the order was delivered to the pharmacy.

With the implementation of UMCL, many of these problems were fixed. There is now a valid and accurate date/time stamp for many steps along the prescription order process. Furthermore, TAT has significantly improved since the implementation of UMCL.

Goals

In order to evaluate the implementation of UMCL, the project team accomplished the following goals:

- Analyzed data from UMCL and Omnicell to measure the impact of the system
- Compared TAT times of the paper system with the UMCL system
- Obtained feedback regarding UMCL from pharmacists, nurses, and physicians
- Developed a plan to improve UMCL TAT in the future

Methodology

To better understand the project, the team conducted a literature search. Past IOE 481 projects and other studies done on computerized order entry systems were referenced for clarity. The project team also collected computerized data and manual data to quantify improvements. The team conducted interviews and surveys with 23 nurses, 12 pharmacists, and 12 physicians to collect opinions of the system. Statistical software was used to analyze the data collected.
Conclusions and Recommendations

The results of this study showed a positive effect of the UMCL system. UMCL reduced TAT by 39.8% for non-Omnicell STAT orders and 23.08% for Omnicell orders. However, UMCL only improved the time from prescription order to verification; it did not affect the time from verification to administration. The team recommends further research in the final entry of prescription administered time and the accuracy of this time. Once this research has been completed, an accurate TAT of the system may be taken electronically from UMCL. Finally, once UMCL has been implemented into the University hospital, another analysis of TAT should be completed to identify any differences from the Mott implementation.

Introduction

The University of Michigan Health System (UMHS) has implemented a prescription order entry system called UM-CareLink (UMCL). UMCL has been implemented on inpatient units within Obstetrics, the Neonatal Intensive Care Unit, and C.S. Mott Children's Hospital. It will be incorporated within UMHS at the end of April 2008. UMCL is expected to improve the turnaround time (TAT) on prescriptions from order entering to administration in comparison to the previous paper system. The project team’s task was to determine if UMCL improved TAT and to quantify the differences between UMCL and the paper system. The team also developed a plan to better monitor TAT in the future. The purpose of this report is to present the team’s data collection, analysis, and recommendations.

Background

With UMCL, physicians enter prescription orders into the electronic system and the orders are sent to the pharmacy immediately. Once the prescription order is entered, it is stored in the UMCL system and WORx system. WORx is a drug therapy management system used to track operations within the pharmacy. Once the pharmacy receives an order, a pharmacist must verify the order. If a problem is discovered, the pharmacist must first resolve the issue before continuing the verification process. After the pharmacist verifies the prescription, the order is filled and prepared for delivery to the corresponding unit. There are four ways prescriptions are delivered: brought to the unit by a pharmacist, picked up by a nurse, obtained from an Omnicell machine, or sent via a pneumatic tube system. Omnicell machines are located around the hospital and are filled with frequently used prescriptions. Omnicell machines allow nurses to access common prescriptions without using the pharmacy. Although the pharmacy does not have to fill the order, a physician still has to enter the order into UMCL. A pharmacist must also verify the Omnicell order within UMCL. A pneumatic tube system within the hospital links the
pharmacy and each unit, allowing prescriptions to be quickly transported. Once received, the nurse administers the prescription to the patient. This process, as well as the pre-UMCL order to administration process from the paper system, can be viewed in Appendix B.

Physicians write prescription orders with different priorities. Most orders are routine, which means they are to be filled in the pharmacy without a time constraint. Urgent orders are marked either STAT, which is defined as an order that must be filled in 15 minutes to 30 minutes, or NOW, which is defined as an order that must be filled in 30 minutes to 1 hour. It was discovered that within UMCL, orders marked NOW enter the pharmacy as STAT orders. Currently, there is basically no difference between STAT and NOW orders, as they are both used for any urgent order.

Prior to UMCL, physicians wrote prescriptions orders on paper. The pharmacy technicians either picked up the orders on rounds, the orders were sent via the pneumatic tube system, or the nurse hand delivered them to pharmacy. There, the orders were verified by a pharmacist. The orders were filled and delivered to the patient in the same manner as with UMCL system.

The paper system presented many problems. The handwriting of physicians was often illegible, causing confusion and potential error. This caused a longer than desired verification process for pharmacists as they had to make phone calls to decipher the hand writing. The paper system did not have a reliable date/time stamp nor did it contain easily accessible records on the patient’s medical history. Additionally, the paper system caused a long wait between the time the physicians wrote the prescription orders and the time these orders were delivered to the pharmacy.

The paper system presented even more problems for data analysis. After analyzing the data from the previous study, an important flaw with the paper system was noticed. Of the 29 STAT orders collected, only 15 of them contained a written time stating the time the prescription was ordered. Within UMCL, all orders that are recorded contain a date and time stamp for the prescription.

The implementation of UMCL fixed many of these problems. Now, the system has a valid and accurate date/time stamp for many steps along the prescription order process and there are no issues with the legibility of physicians’ handwriting. Furthermore, the issue that inspired the need for this study, TAT, has significantly improved since the implementation of UMCL.

Goals

To evaluate the implementation of UMCL the project team accomplished the following goals:

- Analyzed data from UMCL and Omnicell to measure the impact of the system
- Compared TAT times of the paper system with the UMCL system
• Obtained feedback regarding UMCL from pharmacists, nurses, and physicians
• Developed a plan to improve UMCL TAT in the future

**Project Scope**

The team assessed only the TAT of urgent prescription orders (STAT). We only analyzed prescription orders with the UMCL system within Mott Children’s Hospital, specifically PICU, NICU, PCTU, 7 Mott, 6 Mott, 5 East Mott, and 5 West Mott. The prescription TAT begins when a physician enters the order into UMCL and ends when a nurse begins to administer the prescription to the patient. The team has provided recommendations to further improve the medication order process where possible. Additionally, the team analyzed only the processes within the pharmacy that involve UMCL.

There were no alterations made to the UMCL system. The team did not observe or evaluate the prescription filling procedure within the pharmacy. No surveys or interviews involved patients. The project team did not study the procedure of administering medication to patients or make any recommendations regarding the handling of prescription orders by nurses. Mott Children’s Hospital was the only area of the hospital researched.

**Methodology**

The project team conducted a literature search, collected computerized data, performed time studies, and conducted surveys and interviews to analyze UMCL.

*Conducted Literature Search*

To better understand the project, the team first conducted a literature search. Past IOE 481 projects were reviewed for clarity on methodologies, results, and problems encountered. These projects involved similar departments (i.e. Mott Children’s Hospital) and addressed similar subjects (i.e. the order management process). In addition to past IOE 481 projects, the team researched online to see if other hospital systems have implemented similar computerized order entry systems. We discovered that many hospitals have made similar transitions, including the Providence Portland Medical Center and the Ohio State University Medical Center.

The most valuable resource the team referred to was the study done on the paper system, pre-UMCL within the UMHS. Since the goal of the current team’s project was to evaluate the prescription order process post-UMCL, it was crucial to understand the previous study, *Mott Children’s Hospital Medication Turnaround Time Analysis*. The results this project team
developed were compared to prior results. A complete list of the resources referenced can be found in Appendix A.

**Collected Computerized Data and Performed Time Study**

The project team extracted the following data fields from UMCL: order number, WORx order number, patient visit ID, UMCL Drug Name, the date and time the prescription was ordered, the date and time the order was verified by the pharmacist, the date and time the nurse opened the administration window, and the date and time the nurse administered the prescription to the patient.

The team gathered data regarding the time it takes for a message to be transmitted from UMCL to WORx. More precisely, the time that was collected was the time from order entry in UMCL until the time the message was documented as being received by WORx.

In addition to the data that was collected from the computer, the team made observations and performed a time study to further clarify TAT. The fields that were collected in the time study were: the date and time the pharmacist became aware of the STAT order, the date and time the order was ready to leave the pharmacy, the unit where the prescription was delivered, and the delivery method. If the order was to be withdrawn from the Omnicell machine, the field containing the date and time the order was ready to leave the pharmacy was not applicable.

Because Mott Pharmacy provides prescriptions to many units, the team calculated the average walk times to each unit. The team timed five walk routes to the 5th floor units as it very quickly became apparent that most of these times do not vary. As for the units that require elevator use, there was some variation. Five additional replications were completed to account for the variation. A chart containing the average walk time to each unit can be seen in Appendix C.

There were two main data sets used when analyzing TAT of STAT orders: the main set, consisting of the observed data and computerized data and the 2nd set consisting only of the computerized data. To create the main set of data, the project team observed 100 STAT orders. When analyzing the observed data, times had to be omitted due to lack of information or negative time intervals. The lack of information occurred when there were blank fields, specifically the times indicating when the Medication Administration Record (MAR) form was opened and when the drug was administered. The time the MAR form was opened is defined as the time the nurse inputs data in UMCL about administration of the medication to the patient. Often, there were negative interval times and negative total TATs. This problem arose when the administered time was earlier than another time in the process. The nurse specifies what time he/she administered the drug, making this a subjective field in the data set. The team eliminated 18% of the data due to missing fields and 21% of the data due to negative interval times.
Extreme data points were omitted by calculating a trimmed mean. Three orders were omitted from each end of the data set, resulting in a 10% decrease. There were 49 data points in the final data set.

The second set of data consisted of all the STAT orders collected electronically from October 22<sup>nd</sup> to November 25<sup>th</sup>. The same problems were encountered with missing data and negative total TATs. From the 2823 data points, 36% had to be omitted. To acquire a trimmed mean for this data set, the project team removed 5% of the highest TATs and 5% of the lowest TATs. The final data set contained 1623 data points.

The project team used a third data set to analyze the Omnicell orders. Since the delivery method is not recorded in UMCL, data for Omnicell orders had to be extracted from the Omnicell System. The team only examined STAT Omnicell orders with WORx ID numbers that could be traced to the team’s data set of STAT orders. This allowed the team to conduct further TAT analysis. A total of 86 such STAT Omnicell orders were documented from October 22<sup>nd</sup> to November 25<sup>th</sup>. After data points were eliminated due to the data inaccuracies previously stated, 63 orders remained. Further, trimmed mean was obtained by deleting 10% of extreme outliers.

One last part of the prescription order process the team wanted to analyze was the time the tubes take to travel to each unit. A study was performed by an outside part and the data was extracted but it was not received in time to conduct an analysis.

Conducted Interviews and Surveys

UMHS employee perceptions were collected to evaluate the impact of UMCL. Interviews were conducted at the beginning of the project to obtain insight about UMCL and to help determine what survey questions would provide the most valuable information.

After conducting interviews, the team collaborated with the client and coordinator to develop survey questions. The surveys were specific to pharmacists, nurses, and physicians. Surveys were administered to 12 pharmacists, 23 nurses, and 12 physicians. The surveys provided information on employee demographics including; years worked at UMHS, perceptions on UMCL, and the perceived TAT of STAT prescription orders. A copy of the survey questions and format specifically relating to physicians can be seen in Appendix D.

Analysis and Results

The project team compiled the data and surveys to perform the analysis. The team used Minitab, a statistical software program, to analyze the collected data.
The team found averages for each time interval within the process and examined the variation of each time interval. The team inspected time differences between delivery methods (pharmacy technician run, nurse pickup, and Omnicell) and medication destinations.

Data: Post-UMCL

Since the team had access to a large sample of TATs, it was determined that the second set of data would be used for the majority of our analysis. The team collected 49 data points from time studies in order to examine specific intervals within TAT. The team then calculated the percent of TAT dedicated to each interval, and applied these percentages to the large sample to obtain estimates for interval times. The project team divided TAT into four main intervals:

Figure 1: Flowchart of TAT

The flowchart above is a high level map that explains the flow of a prescription from order to administration. The greatest time interval occurs between the time a prescription is ready to leave the pharmacy and when it is administered to the patient. This interval accounts for 83% of TAT. The differences between these four time intervals that compose TAT can be observed in Figure 2.

Figure 2: Box Plots of TAT Intervals
Figure 2 shows the large range and high variation of the 4th interval, exit to administration. The times in this interval range from 4 minutes to 183 minutes. The standard deviation is 55.24 minutes. The cause of this is unknown and out of the scope of this project but could be followed up in a future study for continuous improvement.

**Data: Pre and Post UMCL Comparison**

The pre-UMCL data was obtained from Group 9’s Fall 2006 report, *Mott Children’s Hospital Medication Turn Around Time Analysis*. The time interval between order entry and when the pharmacy receives the order is now almost completely eliminated from the prescription order process. There has been a 91.03% reduction in this time interval since UMCL has been implemented.

Before UMCL, on average, it took 39 minutes from the time an order was written to the time it arrived in the pharmacy. Post UMCL implementation, this same process only takes, on average, 3.5 minutes. The 3.5 minute interval consists of the interface time (average = 6 seconds, standard deviation = 2.24 seconds) and the time it took for a pharmacist to notice the STAT order. The time between order arrival to the time a prescription is ready to leave the pharmacy and the time between leaving the pharmacy and administration stay relatively the same between pre and post UMCL implementation. Figure 3 compares the time intervals of the paper system to UMCL.

![Figure 3: Comparison of non-Omnicell orders Pre and Post UMCL Implementation](image-url)

*Pre-UMCL (Group 9, Fall 2006)*
*Post-UMCL (n = 1623, Team 12, Fall 2007, November 2007)*
The intervals from order arrival to the time the prescription is RTL and from RTL to administration are similar for the paper system and UMCL. The time between order writing and order arrival at the pharmacy has greatly decreased with the UMCL system. In fact, this average interval improved 91.03%.

To see the overall effect of UMCL, the team compared the TAT post-UMCL to Pre-UMCL TAT. Because none of the data involved in this calculation required the observed time fields the project team collected, an average TAT was found using the extracted data from UMCL. According to the pre-UMCL study, the total TAT was calculated to be 98 minutes. Post-UMCL, the total TAT was only 59 minutes, resulting in a 39.8% improvement. Descriptive statistics of TAT data Post-UMCL implementation can be observed in Table 1

| Table 1: Descriptive Statistics of TAT Data Post-UMCL |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| N               | 1623            | Mean            | 59.34           |
| SE Mean         | 1.33            | StDev           | 53.6            |
| Min             | 2.32            | Q1              | 17.62           |
| Median          | 41.47           | Q3              | 85.78           |
| Max             | 250.02          |

n = 1623, Team 12, Fall 2007, November 2007

It can be observed from the Table 1 that there is a high standard deviation. Since TAT has many different factors within the pharmacy and on the hospital floor, there is significant variation within the process. With a median TAT of 41.47 minutes, the majority of the orders have a smaller TAT than the average. The higher average is caused by some of the very large TAT outliers. The distribution of total TAT can be viewed in Figure 4. The vertical line in the figure refers to the mean TAT of 59 minutes.
According to the study on pre-UMCL implementation, the average TAT of Omnicell STAT orders was 65 minutes. This time was broken down into two intervals: the time the prescription was ordered to the time pulled from the Omnicell machine, and the time pulled from the Omnicell machine to patient administration. The first interval had an average of 58 minutes while the second interval had an average of 7 minutes.

Post-UMCL, the total TAT improved 23.08% for Omnicell STAT orders. Figure 5 displays the improvement for Omnicell orders post-UMCL implementation.

Data: Omnicell
The first interval decreased from 58 minutes to 37 minutes. This decrease was from the readily available information with the UMCL system. Prior to UMCL, the paper slips were used to notify a nurse of an Omnicell order. The UMCL system organizes how the nurses receive the order information and therefore has decreased TAT. The second interval actually increased Post-UMCL implementation. This part of the process was not as intensely analyzed and could be part of a later project. Overall, the total TAT of Omnicell orders was reduced.

**Data: Blank Fields**

The team analyzed the data that was discarded in order to understand why so much data was unusable. One source of unusable data were the blank fields within UMCL regarding the time the MAR form was opened and the time of the administration of the prescription. This made TAT impossible to calculate. The team analyzed the 2nd data set consisting of only the computerized data to find a reason for the lack of information. It was discovered that two medications account for 31% of STAT orders with no MAR form or administration information: Bupivacaine 0.125% - Labor, which is entered 98.7% of the time with missing information, and Dietitian Formula Recipe, which is entered 100% of the time without information. The top four medications with blank fields can be observed in Table 2.
Table 2: UMCL Medication Entries

<table>
<thead>
<tr>
<th>Medication</th>
<th># Without UMCL Information</th>
<th>Total # Ordered</th>
<th>% of Time Without UMCL Information</th>
<th>% of Bad Entries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bupivacaine 0.125% - Labor</td>
<td>147</td>
<td>149</td>
<td>98.66%</td>
<td>24%</td>
</tr>
<tr>
<td>Dietitian Formula Recipe</td>
<td>41</td>
<td>41</td>
<td>100.00%</td>
<td>7%</td>
</tr>
<tr>
<td>0.9% NaCl Bolus</td>
<td>26</td>
<td>367</td>
<td>7.08%</td>
<td>4%</td>
</tr>
<tr>
<td>369 Other Medications</td>
<td>399</td>
<td>2266</td>
<td>17.61%</td>
<td>65%</td>
</tr>
</tbody>
</table>

n = 2823, Team 12, Fall 2007, November 2007

These specific medications should be further examined to find the cause of the blank fields within UMCL.

Data: MAR Form

The team performed an analysis to determine if the time between the documented administration of a medication and the time a MAR form is opened to record the administration is significantly different. The team discovered that this time interval was generally small, although there were some very large outliers. Some of these extreme outliers were as small as -31.92 minutes and as large as 8462.6 minutes. The team omitted 5% of the smallest outliers and 5% of the largest outliers to obtain a trimmed mean. The data can be observed in Table 3.

Table 3: MAR Form Data

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>1459</td>
</tr>
<tr>
<td>Mean</td>
<td>13.517</td>
</tr>
<tr>
<td>SE Mean</td>
<td>0.664</td>
</tr>
<tr>
<td>St Dev</td>
<td>25.37</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.133</td>
</tr>
<tr>
<td>Q1</td>
<td>0.517</td>
</tr>
<tr>
<td>Median</td>
<td>0.917</td>
</tr>
<tr>
<td>Q3</td>
<td>14.7</td>
</tr>
<tr>
<td>Maximum</td>
<td>120.917</td>
</tr>
</tbody>
</table>

n = 1459, Team 12, Fall 2007, November 2007

The median time between the MAR form open time and the administration time was 0.917 minutes, 55 seconds, meaning that the interval was generally small. Although the extreme outliers were eliminated, there were still 37 data points that had an interval time over 100 minutes. These points greatly increased the mean. There may be an outside factor that causes
such extreme outliers, but there was no correlation that could be determined using the data collected by the project team.

Data: Units within Mott Children’s Hospital

The data set involving only computer extracted data was used to compare TAT between the units within Mott Children’s Hospital. The units with the highest TAT were 7 Mott with an average of 70.69 minutes and 5 West Mott with a TAT of 70.51 minutes. A complete chart of TATs broken up by units can be seen in Figure 6.

Figure 6 shows that the farther away the unit is from the pharmacy, the longer the TAT. Units within the 5th floor have higher TATs if they are located further from the pharmacy. Units on different floors have increased TATs, the 7th floor having the greatest due to being floors away from the pharmacy. The exception to this trend is 5 West, which should be further analyzed to determine additional factors affecting TAT of this unit.
Surveys: UMHS Employee Perceptions on UMCL

After analyzing the perceptions of pharmacists, nurses, and physicians, it became apparent that UMCL has shortened the total TAT of STAT orders. Only 14.89% of the employees surveyed thought that UMCL did not improve the total TAT. One of the statements employees responded to was: UMCL has improved the STAT medication process from end-to-end, from medication ordering through administration to the patient. The results can be observed in Figure 7.

![Figure 7: Perceptions on TAT Post UMCL Implementation](image)

n = 47, Team 12, Fall 2007, November 2007

Employees were asked to comment on other statements to gain a better understanding of their perceptions. Two of these statements were: patients receive their medication quicker since we implemented UMCL and the medications that come from the pharmacy are available to the nurse when she needs them (i.e. the first time she looks for them). The responses to these statements can be found in Appendix E.

As part of the survey, the project team also asked pharmacists, nurses, and physicians what they perceived the TAT was for STAT orders, pre and post-UMCL implementation. Some employees gave a range for their answer; when this occurred, the project team took the average of the numbers. The results for this question ranged from a minimum of 5 minutes to maximum of 150 minutes. To account for extreme outliers, a trimmed mean was calculated and the top and bottom 10% of times were removed from the data. Pharmacists, nurses, and physicians all agreed that UMCL has reduced the TAT for STAT orders. The perceived percent improvement and perceived trimmed mean (in minutes) can be seen in Table 4.
Table 4: Perceived TAT Pre and Post UMCL Implementation

<table>
<thead>
<tr>
<th></th>
<th>STAT Pre-UMCL</th>
<th>STAT Post-UMCL</th>
<th>% Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmacists</td>
<td>22.81</td>
<td>12.50</td>
<td>45.21%</td>
</tr>
<tr>
<td>Nurses</td>
<td>41.38</td>
<td>29.29</td>
<td>29.20%</td>
</tr>
<tr>
<td>Physicians</td>
<td>56.88</td>
<td>27.50</td>
<td>51.65%</td>
</tr>
</tbody>
</table>

n = 47, Team 12, Fall 2007, November 2007

A complete chart consisting of the perceived means, standard deviations, medians, and trimmed means can also be found in Appendix D.

Surveys: Perceptions based on Years Worked At UMHS

The perceived TAT times were categorized by the demographic fields of age and years worked at UMHS. Figure 8 illustrates the perceptions of employees categorized by years worked at UMHS when asked how they agreed with the statement: UMCL has improved the STAT medication process from end-to-end, from medication ordering through administration to the patient.

Figure 8: Perceptions of Employees by Years Worked at UMHS
Figure 8 shows that as the UMHS experience increases, the positive opinions of UMCL decrease. This tendency may be because people who have worked at UMHS longer are more accustomed to the paper system.

Surveys: Perceptions based on Employee Age

The results of Figure 8 may also be correlated to the age of employees; those who have worked longer are likely to be older. Older employees may have less experience with technology and therefore have negative feedback when moving to a computerized system.

Figure 9 illustrates the perceptions employees categorized by age when asked how they agree with the statement: UMCL has improved the STAT medication process from end-to end, from medication ordering through administration to the patient.

Figure 9: Perceptions of Employees by Age Groups

Figure 9 illustrates as the age of employee increases the positive opinions of UMCL decrease. Again, this tendency can be due to the technological experience of employees. In general, older employees are less likely to have experience with computer systems and therefore will tend to reject the adoption of a new technological system.
**Surveys: Perceptions based on Unit**

Analysis was also done to compare the opinions of UMHS employees based on the unit they work in.

![Bar Chart: Perceived TAT of Employees by Unit](image)

Figure 10: Perceived TAT of Employees by Unit

Figure 10 shows how the perception of turnaround time is higher in 7 Mott, NICU and 6 East than PCTU and 5 West. This perception is probably due to the fact that 7 Mott, NICU, and 6 East are located the farthest from the pharmacy, as medication delivery involves traveling to a different floor. The 5th floor units have the lowest perceived TAT and are closest to the pharmacy. The distance from the pharmacy is reflected in the perceptions of TAT.

**Additional Findings from Observations**

Throughout the team’s research and analysis, there were a few issues and concerns regarding UMCL that the team considers worth mentioning.
UMCL User Friendliness Regarding Physicians

Some physicians have stated that sending an order through UMCL is more difficult than before. The program has a drop down box for order categorization (i.e. STAT, NOW, or routine) but since the default is a routine order, the physician will sometimes forget to change it. This error results in the ordering of a routine order, and not an urgent STAT as the physician intended. While working in the pharmacy, the team found that when this mistake occurs, the physician has to call the pharmacy and change the order to a STAT. These calls distract pharmacy staff and could lead to increased TAT. In addition, when a STAT is called to the pharmacy, it is not recorded in UMCL as a STAT order. For this specific case, data could not be collected.

Shortage of Tubes in the Pharmacy

Another issue we discovered while observing and collecting data in the pharmacy is the shortage of tubes. The shortage of tubes did not occur with the paper system because nurses and doctors would send orders to the pharmacy via the tube system and the medication would be shipped back in the same tube. Since all orders are now electronically entered, the tubes accumulate on the units and do not get sent back to the pharmacy. This problem specifically arises during peak hours and consequently causes increased TAT for orders. In some cases, pharmacy staff has to call the unit and request a tube to send the prescription. The pharmacy then waits for the tube to be shipped and then that prescription is sent to the proper destination.

UMCL Downtime between 6-7 pm

Pharmacists stated that the UMCL system slows down between the hours of 6 and 7 pm. The team observed this problem in the morning also. Some computers took slightly longer than normal to open windows and some computers froze and needed to be restarted. This downtime prevented pharmacists from viewing current orders and caused increased TAT times for these orders.

Communication between Pharmacists and Pharmacy Technicians

While observing the verification and building process of STAT orders, the team noticed that the only mechanism to inform pharmacy technicians of a STAT order was through the verbal notification given by the pharmacist who verified the order. In some cases when the pharmacy was understaffed or experiencing a high volume of orders and the verbal notification was not
given, resulting in urgent STAT orders being built as routine orders, causing increased TAT for those orders.

Medications that are not found in UMCL System

Physicians may ask for some medications that are not in the UMCL system. This complication requires pharmacists to search for additional information not readily available in the system. As a result, TAT is increased.

Physicians Order STAT when is not needed

The team observed that some medications were ordered as STAT but could have been normal routine orders. In the paper system, many orders were given STAT status because of the lengthy TAT time for routine orders. Although TAT has been greatly reduced this logic is still used. For example, a patient might need to take a medication in 4 hours, and a routine order would be adequate for this case. However, the physician might order it STAT just so the medication arrives faster. This unnecessary STAT status of some orders increases the overall TAT.

Pharmacists Pulled Away from Verifying Orders

During understaffed periods in the pharmacy, the team observed that pharmacists may be pulled away from verifying orders to complete other tasks normally handled by pharmacy technicians. STAT orders entered into the system during this time would not be seen by the pharmacist until he/she returned to their verification station, increasing the time between order entry and pharmacist notification affecting overall TAT.

Conclusions and Recommendations

The results of this study show an overall positive effect of the UMCL system. After comparing the average total turnaround of non-Omnicell STAT orders to the paper system, on average TAT was reduced by 39.8%. The significant improvement with UMCL occurred within the interval from order to verification, which has been improved by 91.03%. The rest of the order to administration process did not change significantly.
The team recommends the following actions in order to improve and monitor TAT:

- Reiterate the importance of a standard format for entering prescription orders
- Include the classification (STAT or Routine) on the printed label for the prescription
- Implement a system to flag medications that are not in the UMCL and add these medications to UMCL
- Examine orders that are missing the administration date/time stamp and implement a plan to ensure all data is entered into UMCL
- Extract data periodically and analyze the overall TAT of a sample of STAT orders to compare with the current mean TAT of 59 minutes

The project team recommended a plan for periodic assessment of the current UMCL process. In order to accurately assess UMCL, two issues must be addressed. First, the large percent of data containing blank fields for administration time must be fixed. The hospital should conduct further research to determine how to decrease the percentage of administered times not entered in the system.

Second, the administered time entered should be an accurate measurement of the actual time the prescription is administered. The hospital should conduct further research to determine how to ensure the entered administration times is a true representation of the actual administration time.

Once these two issues have been addressed, an accurate assessment of UMCL may be made electronically involving no observations. Extracting data from UMCL and analyzing the time between the order entry and when the order was administered will give an accurate TAT. This plan can be used to analyze the affect of further improvements made in the UMCL system between order entry and order administration without changing the way data is extracted from the system.

Further studies analyzing the TAT with UMCL should be used after the system is implemented to the University Hospital in April of 2008. Although the processes studied in Mott are similar to that of the university hospital, the pharmacy studied in Mott is specific to a small number of units. The medications and dosages used in Mott are different than that of the university hospital as a whole and could further lead to variation in TAT.
Appendix A: Literature Search


Appendix B: Process Flowchart Comparison

Physician Writes Order

Physician Enters Order

Pharmacist Technician Picks Up Orders on Run

Nurse Sends Order Via Pneumatic Tube

Nurse Runs Order to the Pharmacy

Order Arrives at Pharmacy

Order Arrives at Pharmacy

Pharmacist Verifies Order

Pharmacist Verifies Order

Order Entered in WORx

Medication Pulled From Omnicell

Medication Filled By Pharmacy

Medication Pulled From Omnicell

Medication Filled By Pharmacy

Medication Sent Via Tube

Medication Picked Up By Nurse

Medication Delivered By Pharmacy Tech.

Medication Sent Via Tube

Medication Picked Up By Nurse

Medication Delivered By Pharmacy Tech.

Medication Administered

Medication Administered
Appendix C: Average Walk Times

Table C-1: Average Walk Times

<table>
<thead>
<tr>
<th>Unit</th>
<th>Average Walk Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PICU</td>
<td>42.8</td>
</tr>
<tr>
<td>PCTU</td>
<td>21.9</td>
</tr>
<tr>
<td>NICU</td>
<td>79</td>
</tr>
<tr>
<td>Mott 4</td>
<td>109.5</td>
</tr>
<tr>
<td>5 East</td>
<td>28.4</td>
</tr>
<tr>
<td>5 West</td>
<td>44.8</td>
</tr>
<tr>
<td>Mott 6</td>
<td>101</td>
</tr>
<tr>
<td>Mott 7</td>
<td>126.5</td>
</tr>
</tbody>
</table>

Team 12, Fall 2007, November 2007
Appendix D: Physician Survey

UMHS Program and Operations Analysis Department  
Orders Management Medication Project Survey (PHYSICIAN)

Position/Title:  
Unit:  
How long have you worked at UMHS?  
How long have you worked as a physician?  

Age Range:  
- 20-30  - 30-40  - 40-50  - 50+  

<table>
<thead>
<tr>
<th>Patients receive their medications quicker since we implemented UMCL?</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The medications that come from pharmacy are available to the nurse when she needs them (i.e. the first time she looks for them)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments about TAT? Medication availability or pre/post UM-CareLink?  

UM-CareLink has improved the medication process from end-to-end, from medication ordering through delivery to the patient.  
The average time it took to get STAT/NOW orders from the pharmacy with the old paper system was:  
The average time it takes to get STAT/NOW orders from the pharmacy now with UM-CareLink is:  
The average time it takes to get routine (not STAT/NOW) orders now with UM-CareLink is:  

Thank you!
Appendix E: Survey Results

Figure E-1: Response to Statement - Patients Receive their Medications quicker since we Implemented UMCL

Figure E-2: Response to Statement - Medications that come from the pharmacy are available to the nurse when she needs them (i.e. the first time she looks for them)
**Figure D-3: Perceived TAT**

**Table E-1: Descriptive Statistics – Perceived STAT TAT By Staff position** (minutes)

<table>
<thead>
<tr>
<th></th>
<th>STAT Pre-UMCL</th>
<th>STAT Post-UMCL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pharmacists</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>31.50</td>
<td>14.79</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>34.04</td>
<td>11.25</td>
</tr>
<tr>
<td>Median</td>
<td>17.50</td>
<td>10.00</td>
</tr>
<tr>
<td>Trimmed Mean</td>
<td>22.81</td>
<td>12.50</td>
</tr>
<tr>
<td><strong>Nurses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>47.10</td>
<td>31.33</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>41.35</td>
<td>22.31</td>
</tr>
<tr>
<td>Median</td>
<td>37.50</td>
<td>30.00</td>
</tr>
<tr>
<td>Trimmed Mean</td>
<td>41.38</td>
<td>29.29</td>
</tr>
<tr>
<td><strong>Physicians</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>55.00</td>
<td>27.50</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>34.80</td>
<td>16.30</td>
</tr>
<tr>
<td>Median</td>
<td>60.00</td>
<td>30.00</td>
</tr>
<tr>
<td>Trimmed Mean</td>
<td>56.88</td>
<td>27.50</td>
</tr>
</tbody>
</table>
Table E-2: Descriptive Statistics – Perceived STAT TAT By Unit (minutes)

<table>
<thead>
<tr>
<th>Unit</th>
<th>STAT Post-UMCL (min)</th>
<th>STAT Pre-UMCL (min)</th>
<th>Routine Order Post-UMCL (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>StDev</td>
<td>Median</td>
</tr>
<tr>
<td>7 Mott</td>
<td>45.3</td>
<td>20.2</td>
<td>42.5</td>
</tr>
<tr>
<td>NICU</td>
<td>45.0</td>
<td>21.2</td>
<td>45.0</td>
</tr>
<tr>
<td>6 Mott</td>
<td>40.0</td>
<td>17.3</td>
<td>30.0</td>
</tr>
<tr>
<td>PICU</td>
<td>31.0</td>
<td>22.2</td>
<td>30.0</td>
</tr>
<tr>
<td>PCTU</td>
<td>26.3</td>
<td>26.5</td>
<td>17.0</td>
</tr>
<tr>
<td>5 west</td>
<td>18.8</td>
<td>8.8</td>
<td>18.8</td>
</tr>
</tbody>
</table>

n = 47, Team 12, Fall 2007, November 2007